Announcements

- Homework for tomorrow…

  (Ch. 26, CQ 2, Probs. 4 & 6)

CQ10: A is *negative*
25.16: zero
25.34: 1.8×10^{-5} N, 0^{o} from *x*-axis
25.38: 1.8×10^{-4} N, 52^{o} CW from *x*-axis

Office hours…

MW 10-11 am
TR 9-10 am
F 12-1 pm

- Tutorial Learning Center (TLC) hours:

MTWR 8-6 pm
F 8-11 am, 2-5 pm
Su 1-5 pm

Chapter 26

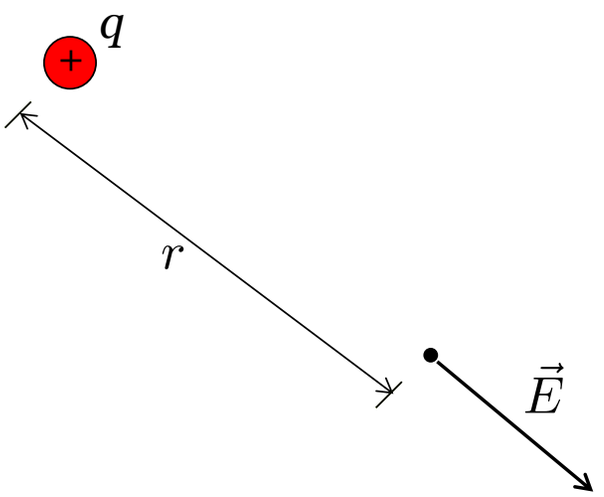
The Electric Field

(*E-Field Models & E-Field of Multiple Point Charges*)

Last time…

- The *Electric field* is defined as…

$$\vec{E} \equiv \frac{\vec{F}_{on\ q'}}{q'}$$



- The *magnitude of the E-field* of a pt. charge is…

$$E = \frac{Kq}{r^2}$$

Permittivity constant..

- Define a new constant..

$$K = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \ \frac{\mathrm{Nm}^2}{\mathrm{C}^2}$$

- so that...

$$\epsilon_0 = \frac{1}{4\pi K} = 8.85 \times 10^{-12} \frac{\mathrm{C}^2}{\mathrm{Nm}^2}$$

8.85×10^{-12}

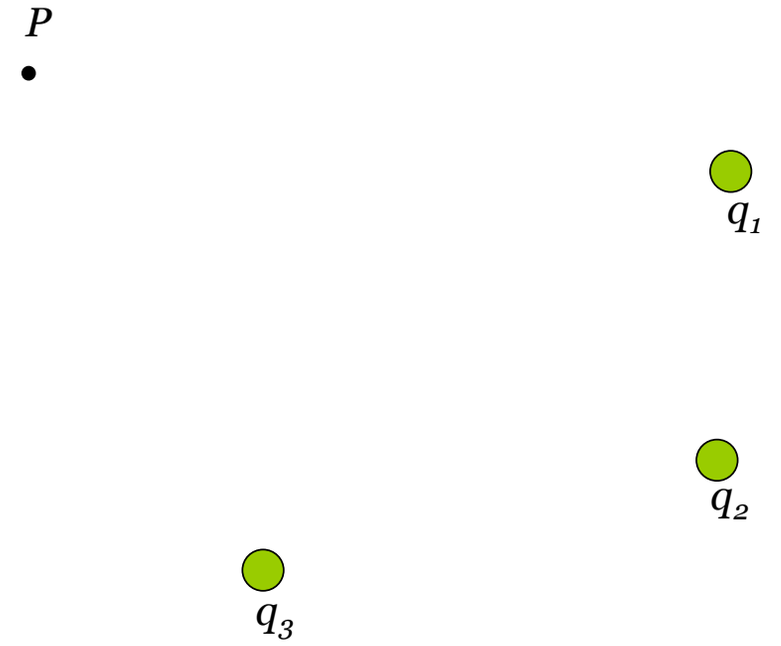
- Coulomb's Law becomes...

$$F_{12} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$$

Electric Fields & Superposition

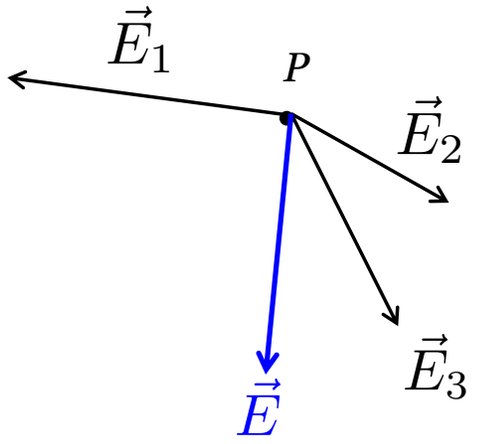
- Q: @ P, what is the E-field?

Vector sum of all the indepent charges



Electric Fields & Superposition

- Q: @ P, what is the E-field?

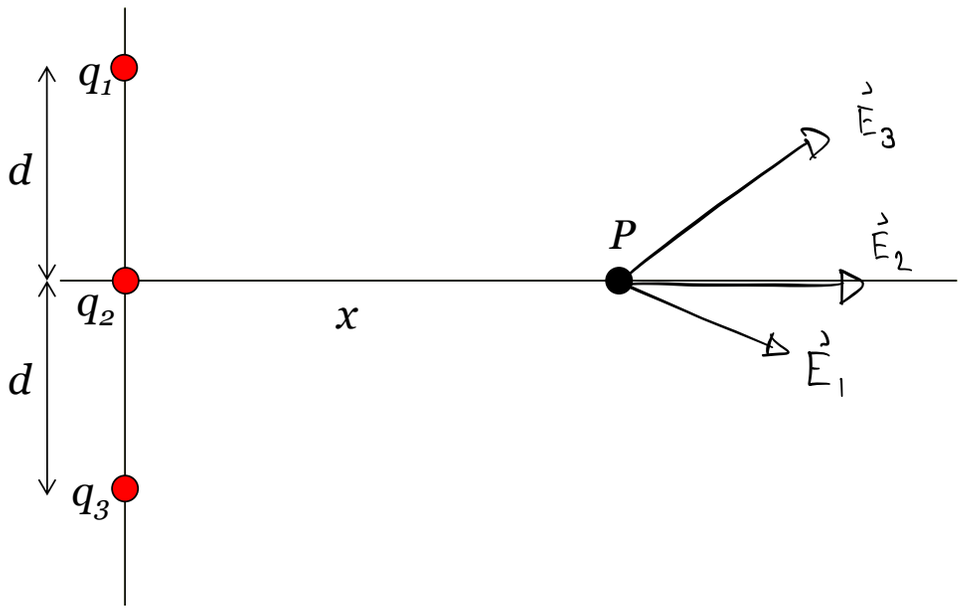


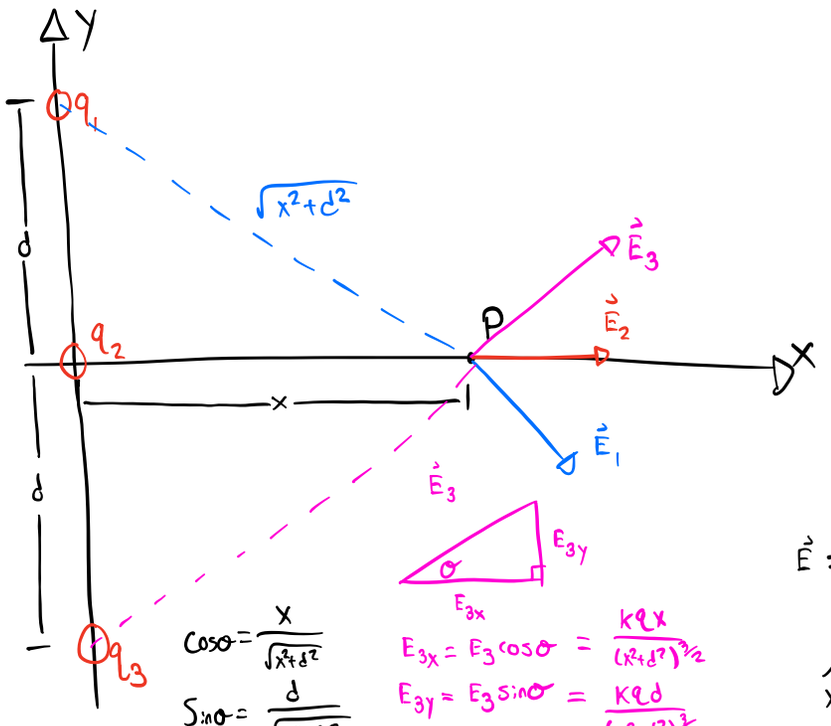
- A: @ P,
  $\vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3$

i.e. 26.1:
The electric field of 3 equal pt. q's

Three equal positive point charges q are located on the y-axis at $y = 0$ and at $y = \pm d$.

What is the electric field at a point on the x-axis?





$q_1 = q_2 = q_3 = q$

$E_2 = \frac{kq}{x^2}\hat{i}$

$E_1 = \frac{kq}{x^2+d^2}$

$E_3 = \frac{kq}{x^2+d^2}$

$E_{3x} = E_3\cos\theta = \frac{kqx}{(x^2+d^2)^{3/2}}$

$E_{3y} = E_3\sin\theta = \frac{kqd}{(x^2+d^2)^{3/2}}$

$\vec{E}_3 = \frac{kqx}{(x^2+d^2)^{3/2}}\hat{i} + \frac{kqd}{(x^2+y^2)^{3/2}}\hat{j}$

$\vec{E}_1 = \frac{kqx}{(x^2+d^2)^{3/2}}\hat{i} - \frac{kqd}{(x^2+d^2)^{3/2}}\hat{j}$

$\vec{E}_2 = \frac{kq}{x^2}\hat{i}$

$\vec{E} = kq\left[\frac{1}{x^2} + \frac{2x}{(x^2+d^2)^{3/2}}\right]\hat{i}$

$\lim_{x\to 0} \vec{E} \to \frac{kq}{x^2}\hat{i}$

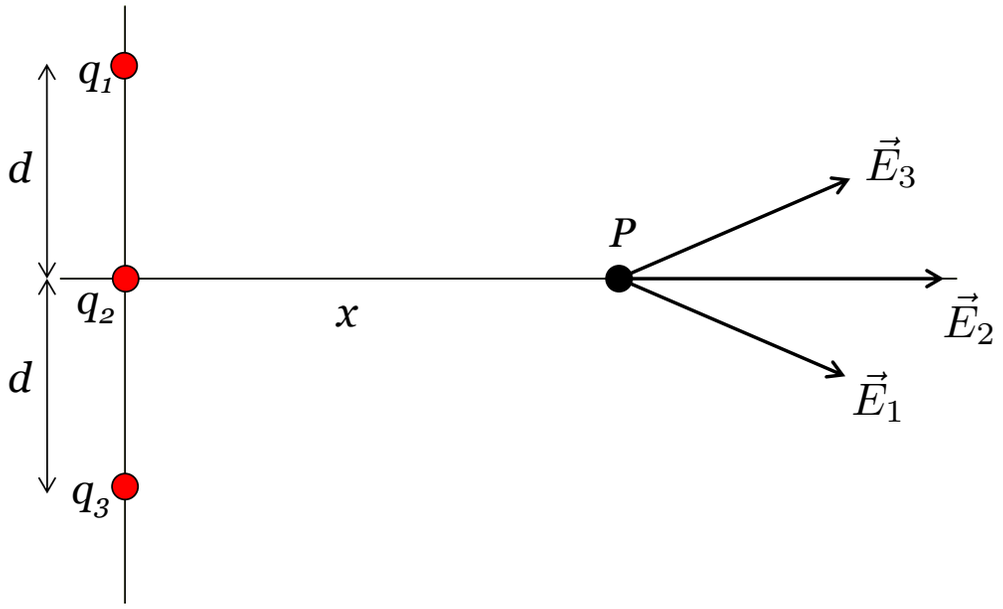
$\lim_{x\to\infty} \vec{E} \to kq\left[\frac{1}{x^2} + \frac{2x}{x^3}\right]\hat{i} = \frac{3kq}{x^2}\hat{i}$

- Field of a point charge of 3q

i.e. 26.1:
The electric field of 3 equal pt. q's

Three equal positive point charges q are located on the y-axis at $y = 0$ and at $y = \pm d$.

What is the electric field at a point on the x-axis?



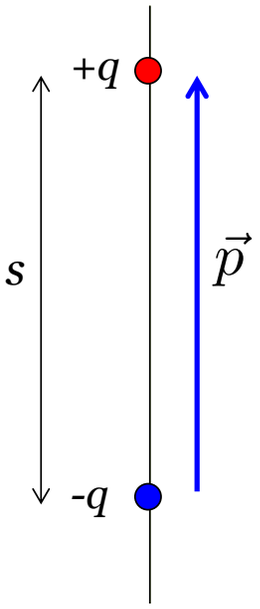
The Electric Field of a Dipole

An *Electric Dipole* is…

- 2 *equal* but *opposite* charges separated by a *small distance.*

Kinds:

- *Permanent* Electric Dipole (i.e. H_2O)
- *Induced* Electric Dipole (i.e. polarized atom)

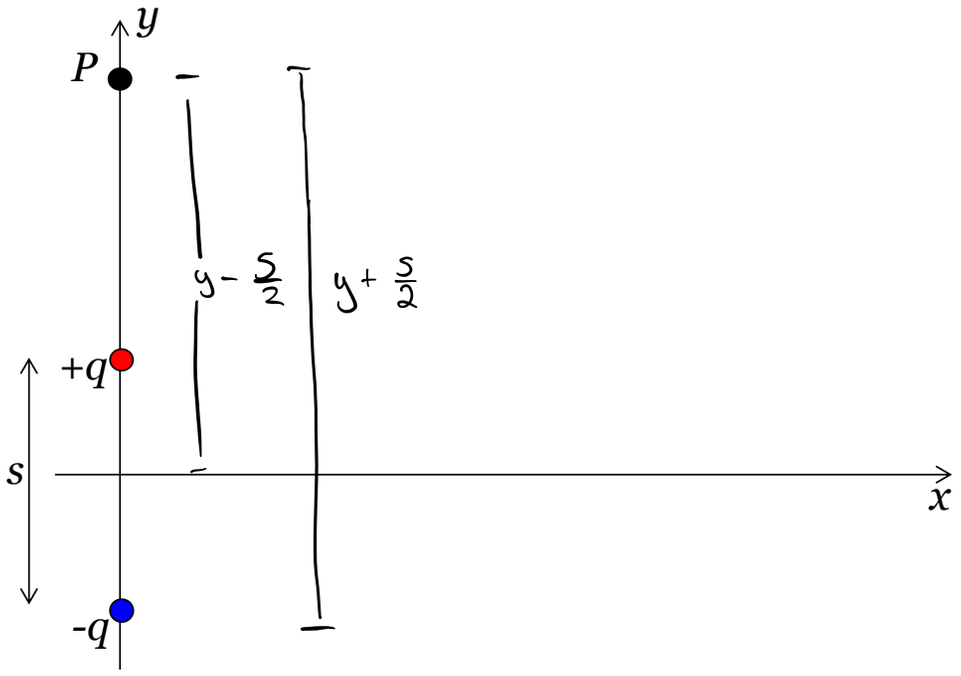


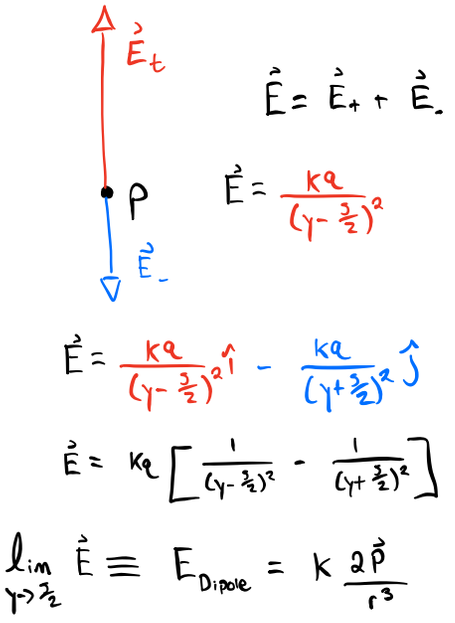
- *Dipole Moment…*

$\vec{p} = qs,$ from the - to + charge

The Electric Field of a Dipole

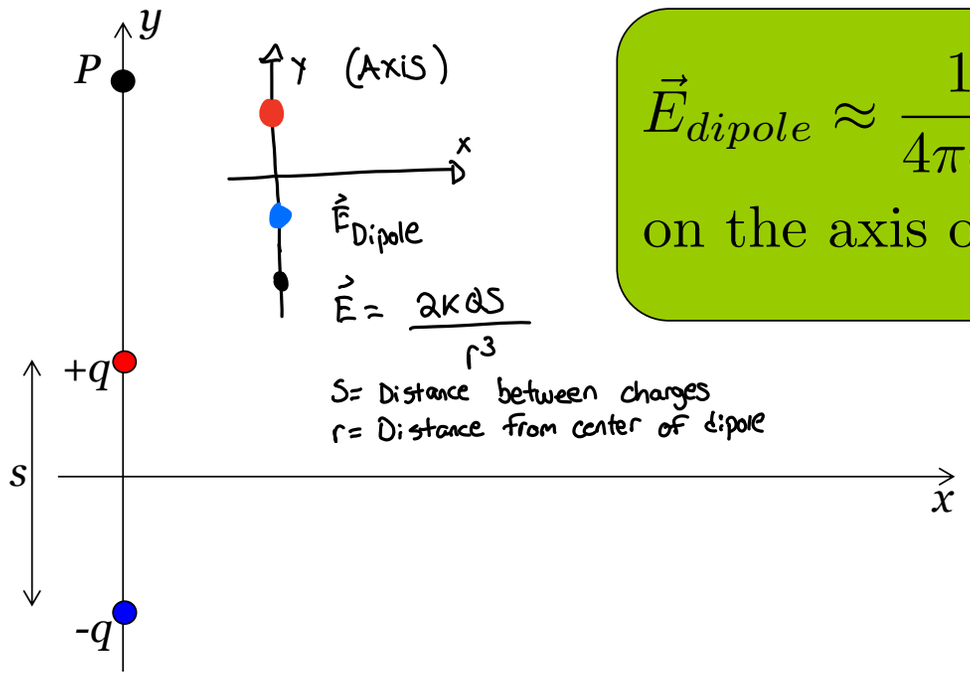
Calculate the *electric field* of a dipole on the *axis of the dipole*…





The Electric Field of a Dipole

Calculate the *electric field* of a dipole on the *axis of the dipole*...



$$\vec{E}_{dipole} \approx \frac{1}{4\pi\epsilon_0}\frac{2\vec{p}}{r^3},$$

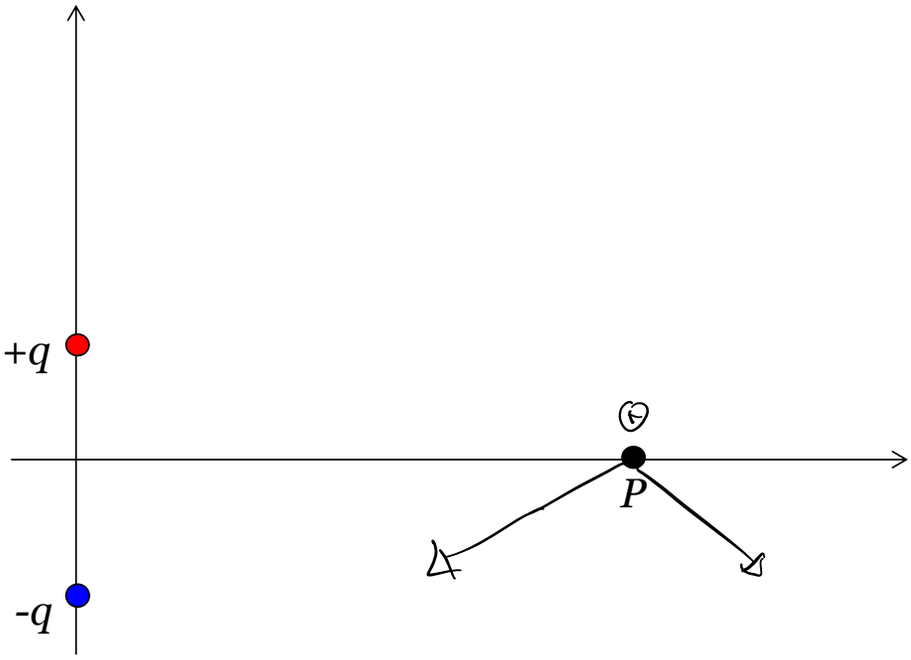
on the axis of the electric dipole

Notice: *r* is distance measured from the *center* of dipole.

Quiz Question 1

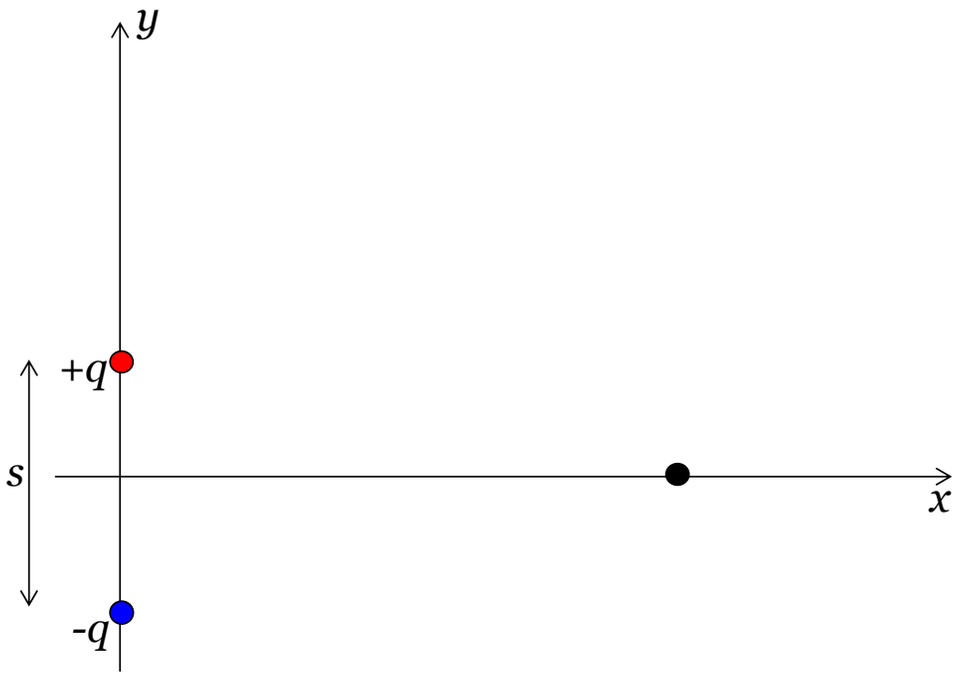
The diagram shows a positive charge $+q$ and a negative charge $-q$ with the *same* magnitude. The electric field at point *P* on the *plane that bisects the dipole* is:

1. Up.
2. Down.
3. Left.
4. Right.
5. Zero.



The Electric Field of a Dipole

Calculate the *electric field* of a dipole in the *plane that bisects the dipole*.



The Electric Field of a Dipole

Calculate the *electric field* of a dipole in the *plane that bisects the dipole*.